CALIFORNIA PRECIPITATION FREQUENCY PROJECT

Expanding NOAA Atlas 14 to Cover All of California

First Progress Report
1 October 2006 to 31 December 2006

Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
National Oceanic and Atmospheric Administration
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DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk.

Table of Contents

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1. Introduction

The Hydrometeorological Design Studies Center (HDSC) within the Office of Hydrologic Development of NOAA's National Weather Service plans to update its precipitation frequency estimates for California. While the semiarid portion of California is covered by NOAA Atlas 14 Volume 1 (Bonnin et al., 2006), the remainder is covered by older estimates contained in "Short Duration Rainfall Frequency Relations for California" (Frederick and Miller, 1979), *Technical Paper No. 49* "Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States" (Miller et al., 1964), *NOAA Atlas 2* "Precipitation-Frequency Atlas of the Western United States" (Miller et al., 1973). This project will extend NOAA Atlas 14 to cover all of California. The update includes collecting data and performing quality control, compiling and formatting datasets for analyses, selecting applicable frequency distributions and fitting techniques, analyzing data, mapping and preparing reports and other documentation.

The project will determine annual precipitation frequencies along with confidence limits (90% confidence level) for durations from 5 minutes to 60 days, for average recurrence intervals from 1 to 1,000 years. Temporal precipitation patterns for heavy rainfall will be extracted for use with the precipitation frequency estimates. In addition, the 1-day annual maximum series will also be analyzed for linear trends in mean and variance and shifts in mean to assess climate change during the period of record.

Rainfall data for the project area will be reviewed and processed using accepted statistical methods. The approach used in this project will largely follow the regional frequency analysis using the method of L-moments described in Hosking and Wallis (1997). For additional details regarding the approach that will be used, please review the documentation for Volumes 1, 2, or 3 available through the Precipitation Frequency Data Server at http://hdsc.nws.noaa.gov/hdsc/pfds/index.html.

During the later stages of the project, the spatial interpolation and the point estimates will be subjected to external peer reviews. The project results will then be published as part of NOAA Atlas 14 on the Internet (http://www.nws.noaa.gov/ohd/hdsc) using web pages with the ability to download digital files.

The project area (Figure 1) covers remainder of the state of California that was not updated in NOAA Atlas 14 Volume 1, the semiarid southwestern United States (Bonnin et al., 2006).

This document is the first of a series of Quarterly Progress Reports which will be published during the life of the project.

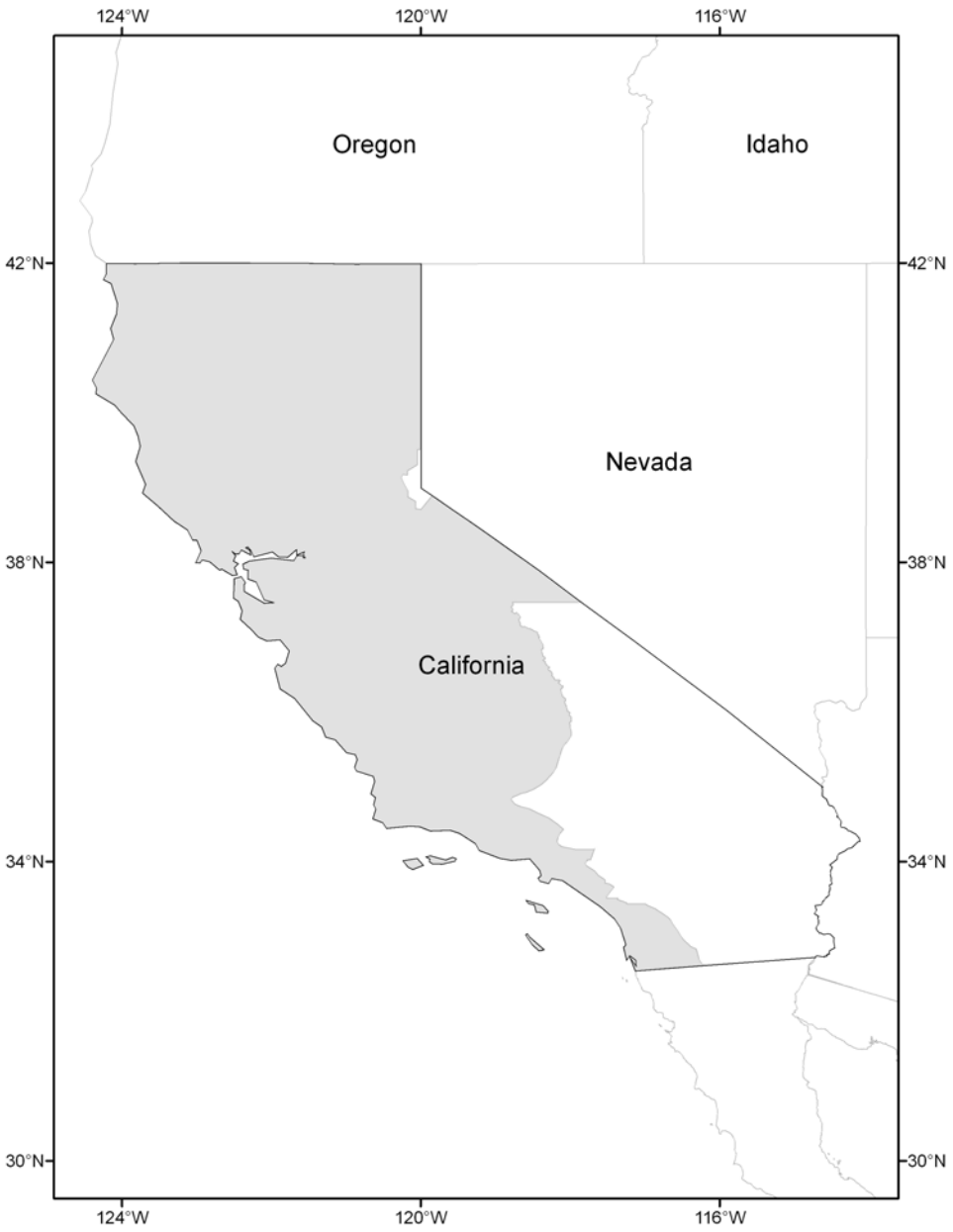

Figure 1. California Precipitation Frequency Project area depicted in grey shading.

2. Highlights

HDSC is in the process of collecting all available precipitation datasets - daily, hourly, 15-minute, and n-minute. Daily and hourly data from NCDC and ALERT data from the San Diego Flood Control District have been obtained. Some quality control of the metadata associated with the NCDC data has begun. Additional information is provided in Section 3.1, Data Collection and Quality Control.

HDSC continuously monitors the integrity and performance of the Precipitation Frequency Data Server (PFDS), the on-line portal for all NOAA Atlas 14 deliverables and information. Additional information is provided in Section 3.2, PFDS.

Work continues on the development of geographically fixed Areal Reduction Factors (ARFs) for area sizes of 10 to 500 square miles and durations of 30-minutes to 48-hours for the United States. Additional information is provided in Section 3.3, Areal Reduction Factors.

3. Progress in this Reporting Period

3.1 Data Collection and Quality Control

HDSC is in the process of collecting all available precipitation datasets - daily, hourly, 15-minute, and n-minute. On November 30th, 2006, an email was distributed to potential users and collaborators in an effort to obtain all available data sets for the California project area. Response was excellent with information from 15 individuals regarding additional sources of data. In other projects, such local datasets have proven extremely useful either spatially or temporally increasing the certainty of the final estimates. Input and cooperation from local experts is much appreciated and is a key component to computing the best possible estimates.

Data are being collected for the project area and border areas that extend partly into Nevada and Oregon. Daily and hourly data have been downloaded from the National Climatic Data Center (NCDC). Metadata (latitude, longitude and elevation) were absent from 324 stations for CA, NV, and OR. Metadata for 251 of the 324 have been found through the on-line “Web Search Store Retrieve Display”, a.k.a. WSSRD, at http://noaa.imcwv.com/ which is maintained by NCDC.

Data in the border areas are included to generate reliable estimates and create smooth transitions along those borders. Data in these border areas from the previously published Volume 1 will be updated through 2005 (or 2006 if available). This update should not result in much difference in estimates due to robustness of the regional approach using L-moments (Hosking and Wallis, 1997). Published estimates in the Volume 1 project area will not change; therefore border smoothing will be critical during the spatial interpolation stage of the process.

ALERT data have also been received from the San Diego Flood Control District. These data are being processed and formatted.

Other potential data sets such as SNOTEL and USGS data will be obtained. In addition, data in the Santa Barbara area originally obtained and quality controlled as part of the Areal-Reduction-Factor project will be updated and included.

3.2 PFDS

HDSC continuously monitors the number of inquiries (hits), integrity and performance of the PFDS, which continues to receive a steady number of hits per month. The graph (Figure 2) below summarizes the number of individual data inquires made since December 2004, while the map (Figure 3) indicates the locations of inquires during the past quarter.

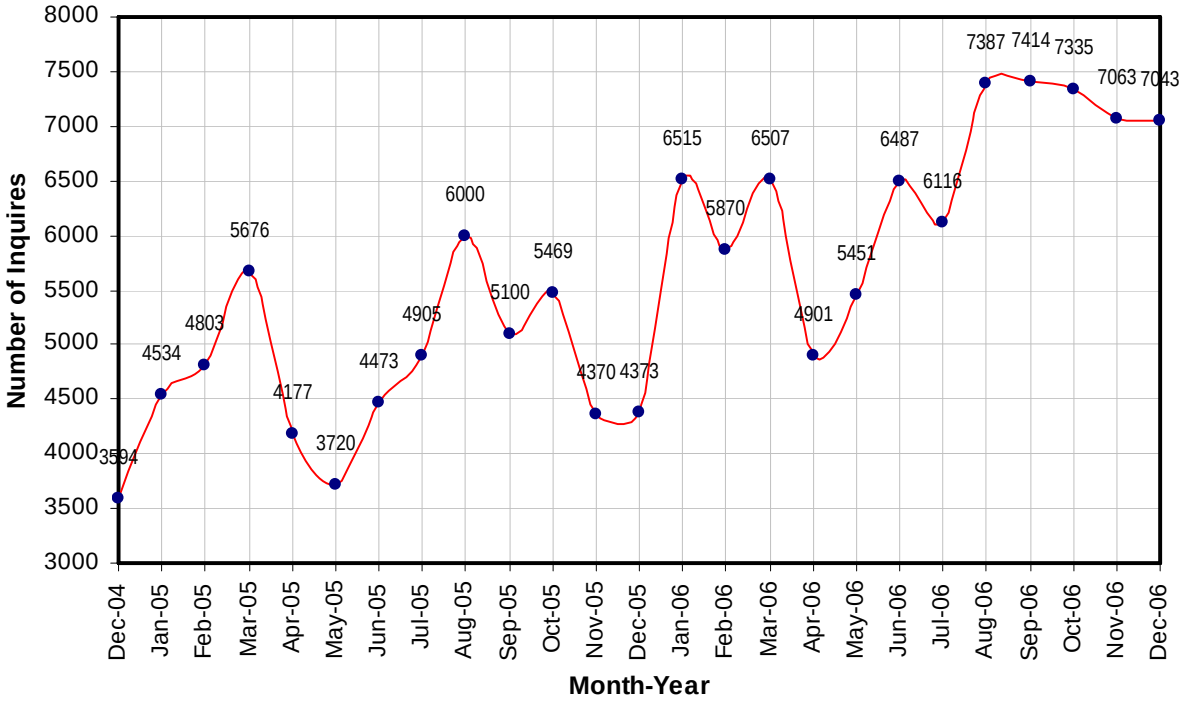

Figure 2: Number of individual PFDS data inquires per month.

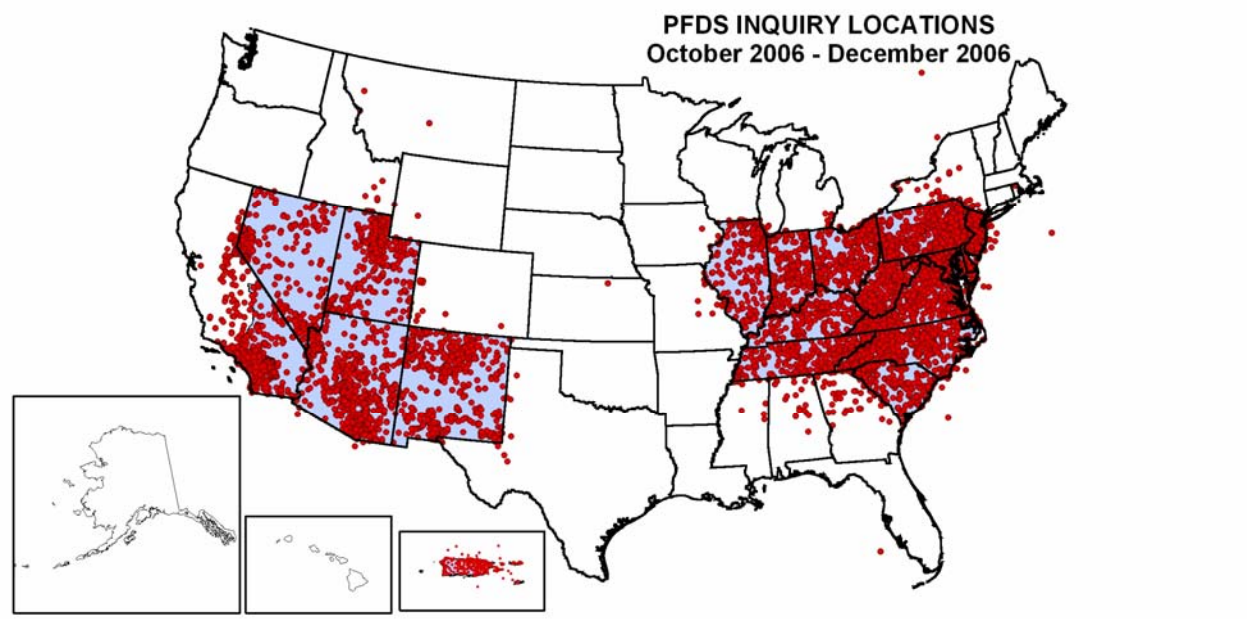

Figure 3: Map of 21,441 PFDS data inquiry locations during the period October-December 2006.

3.3 Areal Reduction Factors

Work continues on the development of geographically-fixed Areal Reduction Factors (ARFs) for area sizes of 10 to 500 square miles and durations of 30-minutes to 48-hours for the United States. The results of this supplementary study will be applicable to all volumes of NOAA Atlas 14.

Although ARF software development has been slow, it continues to move forward. The continuing goal is to develop ARF software based on the NOAA Technical Report NWS 24 (Myers, V.A. and R.M. Zehr, 1980) methodology and obtain the same results published in TR-24 for the Chicago rain gauge network. The ARF computations are a function of six variables that vary in time and space. Fitting functions (curves) to these six variables so that the results are equal to those in TR-24 has been difficult.

Figure 4 shows the locations of all used, not used and considered rain gauge networks. Meanwhile, Table 1 provides additional details of the preliminary study areas. Unless we are made aware of quality rain gauge networks that meets our criteria (10+ years of concurrent hourly precipitation data at 10+ gauges over an area of ~100 to ~500 square miles), we are not actively seeking additional networks. We have identified, pre-processed and quality controlled hourly precipitation data for 15 networks that we believe will anchor the final ARF results. Seven additional networks have the potential of being added to the base ARF database.

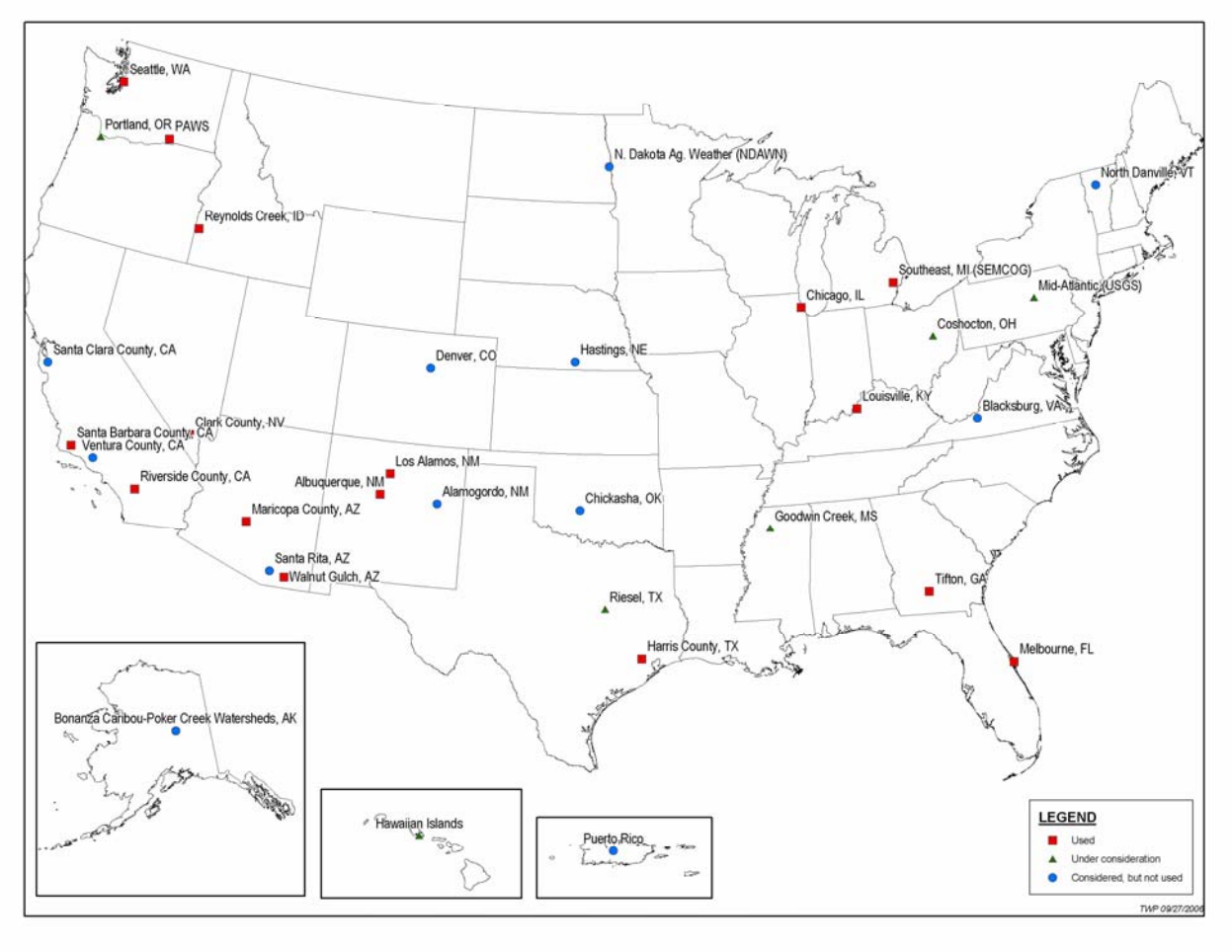

Figure 4. Map of ARF study areas.

Table 1. Preliminary ARF study areas.

Study area location	Included?	Date Range	Approx size (sq-mi)	No. of stations	Lat.	Long.	Average Elevation (ft)
Albuquerque, NM	Yes	1978-1992	400	13	35.161	-106.566	5311
Chicago, IL	Yes	1949-1980	n/a	18	41.830	-87.692	618
Clark County, NV	Yes	1990-2004	n/a	48	36.290	-114.978	940
Los Alamos, NM	Yes	1990-2005	150	9	35.858	-106.282	7011
Maricopa Cty, AZ	Yes	1980-2001	n/a	31	33.789	-112.303	2572
Reynolds Creek, ID	Yes	1962-1996	n/a	44	43.169	-116.769	5342
Riverside Cty, CA	Yes	1961-2001	n/a	45	33.793	-116.995	1987
Santa Barbara, CA	Yes	1968-2003	n/a	38	34.590	-119.957	1203
Seattle, WA	Yes	1978-2003	216	23	47.553	-122.333	152
South-central Washington state (PAWS)	Yes	1989-2005	700	15	46.071	-119.306	765
Southeast Michigan Council of Governments (SEMCOG)	Yes	1988-2002	n/a	50	42.518	-83.286	730
Melbourne, FL	Yes	1997-2005	450	35	28.545	-80.634	0
Harris County, TX	Yes	1997-2005	3800	165	29.779	-95.405	-999
Walnut Gulch, AZ	Yes	1954-1996	n/a	107	31.728	-110.024	4656
Jefferson County, KY	Yes	1991-2005	n/a	18	38.190	-85.670	-999
Chickasha (Micronet), OK	Maybe	1994-2005	1130	44	34.885	-98.075	398
Coshocton, OH	Maybe	1940-2001	n/a	22	40.435	-81.799	1044
Goodwin, MS	Maybe	1981-1996	n/a	32	34.232	-89.914	333
Portland, Oregon HYDRA	Maybe	1976-2005	200	45	45.537	-122.662	-999
Tifton, GA	Maybe	1968-1981	n/a	55	31.439	-83.590	-999
Ventura, CA	Maybe	n/a	n/a	134	34.370	-119.067	-999
Hawaii	Maybe	1948-2005	n/a	n/a	n/a	n/a	n/a
Alamogordo Creek, NM	No	1955-1962	67	64	34.920	-104.143	4898
Blacksburg, VA	No	n/a	n/a	<10	37.250	-80.417	-999
Denver, CO	No	n/a	n/a	n/a	39.750	-105.000	-999
Ft. Collins, CO	No	1999-2005	12		40.567	-105.093	5099
Riesel, TX	No	n/a	10	39	31.482	-96.880	544
Hastings, NE	No	1938-1967	n/a	19	40.255	-98.376	-999
North Danville, VT	No	1958-1975	n/a	27	49.678	-74.724	2118
Puerto Rico	No	1973-2003	500	10-18	18.260	-65.910	800
Mid-Atlantic DCP and Metar network	No	1990-2004					
Bonanza, Caribou-Poker Creeks Watersheds, AK	No	n/a	50	n/a	64.750	-148.230	1641

4. Issues

4.1 Upcoming Presentations

Geoff Bonnin will present a paper, *Updates to NOAA Precipitation Frequency Atlases*, (authors Geoffrey M. Bonnin, Deborah Martin, Bingzhang Lin, Tye Parzybok, Michael Yekta, David Riley, Lillian Hiner, Daniel Brewer) at the EWRI World Environmental and Water Resources Congress in Tampa, Florida, in May 2007. The paper was prepared and submitted.

5. Projected Schedule and Remaining Tasks

The following list provides a tentative schedule with completion dates. These dates are subject to change based on the actual resources that will be required at each step. Also, the challenges that may be presented by the data are as yet unknown. However, this schedule is based on our experience preparing the existing NOAA Atlas 14 Volumes. Brief descriptions of tasks that will be worked on during the next few quarters are also included in this section.

Data Collection [May 2007]
Data Quality Control [August 2007]
Regionalization (24-hour and 60-min) [November 2007]
L-Moment Analysis/Frequency Distribution (all durations) [January 2008]
Trend Analysis [October 2007]
Temporal Distributions of Extreme Rainfall [December 2007]
Peer Review of estimates [April 2008]
Spatial Interpolation [August 2008]
Precipitation Frequency Maps [October 2008]
Web Publication [September 2008]
Documentation [September 2008]

Areal Reduction Factors [June 2007]

5.1 Data Collection and Quality Control.

During the next quarter, the formatting of daily and hourly data from NCDC and of the ALERT data from San Diego will be completed. Collection of data from other potential sources will begin. Formatted data will be prepared for quality control.

5.2 Areal Reduction Factors (ARF)

Either code will be completed to compute the ARF curves or alternative methods will be considered during the next quarter. Computations for the ARF curves will begin in the next quarter for 14 areas. The resulting curves will be tested for differences to determine if a single set of ARF curves is applicable to the entire U.S. or whether curves vary by region.

References

Bonnin, G., D. Martin, T. Parzybok, B. Lin, D. Riley, and M. Yekta, 2006: Precipitation frequency atlas of the United States. NOAA Atlas 14 Volume 1 Version 4.0, Silver Spring, Maryland. http://hdsc.nws.noaa.gov/hdsc/.

Frederick, R.H. and J.F. Miller, 1979: Short Duration Rainfall Frequency Relations for California, Third Conference on Hydrometeorology, August 20-24, 1979 in Bogata Columbia. American Meteorological Society, Boston, MA.

Hosking, J.R.M. and J.R. Wallis, 1997: *Regional frequency analysis, an approach based on L-moments*, Cambridge University Press, 224 pp.

Miller, J.F., 1964: Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States, *Technical Paper No. 49*, U.S. Weather Bureau and U.S. Department of Agriculture, 29 pp.

Miller, J.F., R.H. Frederick and R.J. Tracy, 1973: Precipitation-frequency atlas of the western United States, *NOAA Atlas 2*, 11 vols., National Weather Service, Silver Spring, MD.

Myers, V.A., and R.M. Zehr, A Methodology for Point-to-Area Rainfall Frequency Ratios, NOAA Technical Report NWS 24, Office of Hydrology, National Weather Service, Silver Spring, Maryland, February 1980.